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(54) Automatic backup trunking for voice over the internet

(57) To reduce telephone toll costs to a user, a PBX preferentially establishes a call to a destination number (DN) over a WAN or the internet. The PBX determines the available connection types available by querying look-up tables for the particular DN. If no alternatives to the PSTN are available, the call is routed over the PSTN. Where a WAN or internet connection is available, the call is then routed over this alternative service. If the Quality of Service (QoS) over the computer network connection falls below a specified threshold, a second parallel connection is made over the PSTN and the call is then transferred to the PSTN. The user is notified of this change in service. During the PSTN connection, the PBX polls the alternative service and, upon the QoS rising above a specified threshold, the call is then routed back to the alternative service and the PSTN connection is torn down. The user is again notified of this change in service.

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to a method and apparatus for routing a telephone call.

[0002] Voice communication over the internet is known. However, such communication typically requires that both parties be logged on to an internet provider, be running compatible voice communication software, and have the necessary hardware (e.g., microphone and speakers). Further, voice communication over the internet may degrade due to congestion.

[0003] The present invention seeks to obviate disadvantages of known voice communication over the internet.

SUMMARY OF THE INVENTION

[0004] According to the present invention, there is provided a method for routing a telephone call, comprising the steps of: receiving a destination number (DN) for said call; based on said DN, determining whether a connection is possible through a computer network; where a computer network connection is possible, routing said call through said computer network; where a computer network connection is not possible, routing said call through a switched telephone network.

[0005] According to another aspect of the present invention. there is provided a call router for routing a telephone call, comprising: a receiver for receiving an outgoing call; a detector responsive to said receiver for detecting a destination for said call; a determiner responsive to said destination detector for determining whether or not a connection is possible through a computer network; a route initiator responsive to said determiner for initiating a route for said call through one of said computer network and a switched telephone network.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In the figures which show an example embodiment of the invention,

figure 1 is a schematic view of a communication system embodying this invention,

figure 2 is a schematic detail of a portion of figure 1, and

figures 3a and 3b comprise a flow diagram of the program control for a portion of the system of figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0007] Turning to figure 1, a communication system illustrated generally at 10 comprises a plurality of telephone appliances 12 connected to a first private branch exchange (PBX) 14 and a plurality of telephone appliances 22 connected to a second PBX 24. PBX 14 and PBX 24 are each connected to a wide area network (WAN), or intranet, 40, an internet 42, and a public switched telephone network (PSTN) 44.

[0008] Referencing figure 2, PBX 14 comprises a processor 52 connected for two-way communication with a memory 54 and having a control input to a switch matrix 56. The switch matrix has inputs 58 from telephone appliances connected to the PBX and outputs 60 to these telephone appliances and to intranet, internet, and PSTN lines. PBX 24 is identically configured.

[0009] The operation of the communication system of figures 1 and 2 is described in conjunction with figures 3a and 3b, which illustrates the program control for processor 52 of PBX 14.

[0010] If a user of telephone appliance 12a goes off-hook and dials a destination number (DN) for telephone appliance 22a, the PBX 14 receives the DN (block 110). The processor of the PBX retrieves a WAN look-up table from memory 54 and determines whether the DN appears in the table (block 112). If yes, this means that the DN is for a telephone appliance associated with a PBX on the WAN and the processor retneves the WAN address associated with the DN from the look-up table (block 114). The WAN address is an indication of a destination PBX on the WAN to which the called telephone appliance is associated. In the illustrative example, the address for PBX 24 would appear in the WAN table. With this information, PBX 14 routes the call through its switch matrix 56 to a WAN line and initiates routing through the WAN in order to complete the call (block 116), verifying in the process that the Quality of Service (QoS) is high enough to support a real-time telephone conversation by measuring the packet delay.

[0011] If the user of telephone 12a dialled the DN for a telephone appliance not on the WAN or the call required a QoS above that available on the WAN, then PBX 14 next accesses an internet look-up table and searches for the DN (block 118). If an entry is found, the internet address is retrieved (block 120) and the PBX 14 initiates routing through the intemet to the destination PBX (block 122), verifying in the process that the QoS is high enough to support a real-time telephone conversation.

[0012] Assuming PBX 14 did not have an internet look-up table entry for the DN, or the QoS was not high enough to support a telephone conversation, the PBX initiates routing of the call through the PSTN (blocks 124, 130).

[0013] Whenever a call is established over the intemet. PBX 14 monitors the quality of service (QoS) of the internet call path (block 134). This involves measuring such parameters as packet delay, the number of data packets dropped and throughput. Preferably QoS is measured using the known Real-Time Transport Control Protocol (RTCP). If the QoS falls below a first threshold (block 136), then PBX 14 initiates the setting up of a

parallel call path to the destination PBX over the PSTN. Once this parallel path is established. PBX 14 sends a sequence of in-band tones over the PSTN to the destination PBX which uniquely identifies the internet connection carrying the call's voice path connection (e.g. the calling and called telephone numbers). The destination PBX sends a confirmation tone over the PSTN to PBX 14 indicating when it has found the connection. (This interaction is done over the PSTN instead of over the internet because the internet is assumed to be suffering delays due to congestion at this time.) The confirmation tone is used as a signal for both PBXs to simultaneously switch the voice path from the internet to the PSTN. Since the internet voice path is suffering quality problems such as excessive delay, it will normally be acceptable to switch the voice path without waiting for a silence interval. A notification tone can be sent to the calling and called parties during a silence interval to notify them that the call has been rerouted. Typically a PSTN connection generates higher user charges than an internet connection and so the alerting informs the parties of their use of a higher price connection.

[0014] After the change-over. the internet call path is maintained and PBX 14 sends test packets over the internet call path to allow it to continuously monitor the QoS of the connection (block 144). If the QoS improves so as to exceed a second threshold -- which may be set higher than the first threshold (block 146). PBX 14 monitors for silence on the PSTN connection, then initiates routing of the call through the internet (block 148). The PBX may also send an in-band signal to alert the parties of a switch over back to the internet connection. The PBX then initiates tearing down of the PSTN connection (block 150).

[0015] For the duration of the call, PBX 14 monitors the QoS of the internet connection and re-establishes a PSTN connection whenever necessary.

[0016] In the foregoing, it is assumed that the WAN 40 is able to guarantee a QoS for each connection. If this is not the case, then the PBX 14 monitors and responds to the QoS on the WAN in the same fashion as it monitors and responds to the QoS on the internet.

[0017] By utilising a computer network (intranet or internet) call path in preference to a PSTN call path, the communication system 10 minimizes toll costs of a call. Additionally, the communication system 10 provides a "safety factor" for any call over a computer network in that should the QoS of the call degrade for any reason, the call will be rerouted through the PSTN.

[0018] While figure 1 illustrates two networked PBXs, it will be readily apparent that any number of PBXs may form part of a "corporate" network. When any new PBX is to join the corporate network and this new PBX is connected to the internet, a system operator enters the internet protocol (IP) address of a "reference" PBX in the corporate network. The reference PBX can be any active PBX of the corporate network which has an internet connection. This prompts the new PBX to send a message to this IP address identifying itself as a new PBX on the corporate network along with the range of DNs to which it responds and an authentication code. The reference PBX returns a message which contains a mapping between corporate network DN ranges and IP addresses for all of the PBXs in the corporate network. The new PBX stores this information in a look-up table and then sends a message to each of the PBXs in the corporate network identifying itself as a new PBX on the corporate network and specifying the range of DNs to which it responds. Upon receiving this message, the other PBXs update their look-up table to include this new PBX. This same procedure may be used to incorporate a new PBX in a WAN of the corporate network.

[0019] Efficiency of the corporate network may be further enhanced by a modification wherein each PBX periodically sends test messages to each of the other PBXs in the corporate network to determine the quality of service of the WAN/internet connections between itself and the other PBXs. If it determines that the quality of service with another PBX is not high enough to support an acceptable voice conversation, it will set a "poor Voice Quality" flag in a look-up table indicating that calls to this PBX should be routed over the PSTN. This flag will be cleared when subsequent tests indicate that the quality of service achievable over the WAN/internet connection to this PBX has returned to an acceptable level.

[0020] With this modification, when a user places a call to a remote PBX, the load PBX will look up the IP address of the remote PBX and check the Poor Voice Quality flag associated with that PBX. If the remote PBX has an IP address in the look-up table and its Poor Voice Quality flag is not set, the local PBX will set up the call over the WAN or internet. Otherwise it will set up the call over the PSTN.

[0021] While the illustrative embodiments reference the PSTN, it will be appreciated that this network could equally be a network of leased lines or other switched telephone network. If the switched telephone network does not support an end-to-end digital connection. it may be necessary to convert an incoming call from analog to digital in any known fashion before the call is routed over an internet connection.

[0022] Each PBX in the illustrative embodiment could be replaced by any intelligent switch. Further, instead of programming a PBX or other intelligent switch to perform as described. a special purpose router could be associated with the switch. The switch would then be programmed to query the router for instructions whenever a call arrived and the router would instruct the switch to operate in the manner described for the PBX hereinbefore. As a further alternative, if the switch was a signal switching point (SSP) in an advanced intelligent network (AIN), then, as is standard in an AIN, the SSP queries a supervisory control point (SCP) when a call arrives. The SCP could contain the program control for the SSP such that the SSP operated in the manner hereinbefore described for the PBX.

[0023] In summary, to reduce telephone toll costs to a user. a PBX preferentially establishes a call to a destination number (DN) over a WAN or the internet. The PBX determines the available connection types available by querying look-up tables for the particular DN. It no alternatives to the PSTN are available, the call is routed over the PSTN. Where a WAN or internet connection is available. the call is then routed over this alternative service. If the Quality of Service (QoS) over the computer network connection falls below a specified threshold, a second parallel connection is made over the PSTN and the call is then transferred to the PSTN. The user is notified of this change in service. During the PSTN connection, the PBX polls the alternative service and, upon the QoS rising above a specified threshold, the call is then routed back to the alternative service and the PSTN connection is torn down. The user is again notified of this change in service.

[0024] Other modifications will be apparent to those skilled in the art and. therefore. the invention is defined in the claims.

Claims

1. A method for routing a telephone call, comprising the steps of:

   receiving a destination number (DN) for said call;
   based on said DN, determining whether a connection is possible through a computer network;
   where a computer network connection is possible, routing said call through said computer network;
   where a computer network connection is not possible, routing said call through a switched telephone network.

2. A method claimed in claim 1, including the steps of:
   where said call is routed through said computer network, monitoring a quality of service for said call and, where said quality of service falls below a threshold, dynamically rerouting said call through said switched telephone network.

3. A method as claimed in claim 2, wherein said step of dynamically rerouting comprises the steps of:

   setting up a call path on said switched telephone network which is parallel to an existing call path for said call on said computer network: and
   switching said call from said computer network path to said switched telephone network path.

4. A method as claimed in claim 2 or claim 3, including the steps of:

   maintaining said computer network path;
   sending test data packets on said computer network path;
   monitoring a quality of service for said test data packets;
   where said test packets quality of service exceeds a threshold, switching said call from said switched telephone network path back to said computer network path and tearing down said switched telephone network path.

5. A method as claimed in any one of claims 2 to 4, including the step of monitoring for a natural break in communication on said computer network path and wherein the step of switching is responsive to said monitoring step.

6. A method as claimed in claim 5, including the step of generating an in-band signal on the switching step.

7. A method as claimed in any preceding claim, wherein said computer network comprises an internet and/or an intranet and wherein said switched telephone network comprises a public switched telephone network (PSTN).

8. A method as claimed in claim 7, including the steps of:

   where an intranet connection is not possible, determining if an internet connection is possible; and
   where an intranet connection is not possible and an internet connection is possible, routing said call through said internet preferentially to routing said call through said switched telephone network.

9. A method as claimed in any preceding claim, including the steps of, where a computer network connection is available:

   repeatedly testing a quality of service of said computer network connection;
   storing an indication of whether or not said quality of service is poor based on said testing;
   determining whether a computer network connection is possible based on said stored indication.

10. A call router for routing a telephone call, comprising:

    a receiver for receiving an outgoing call;
    a detector responsive to said receiver for detecting a destination for said call;

a determiner responsive to said destination detector for determining whether or not a connection is possible through a computer network;
a route initiator responsive to said determiner for initiating a route for said call through one of said computer network and a switched telephone network.

11. A router as claimed in claim 11, including a monitor for monitoring a quality of service for said call where said call is routed through said computer network and for, where said quality of service falls below a threshold, causing said route initiator to dynamically reroute said call through said switched telephone network.

12. A router as claimed in claim 12, including a signal generator responsive to an output of said monitor for generating an in-band signal when said route initiator reroutes a call.

13. A telecommunications network including a router as claimed in any one of claims 10 to 12.

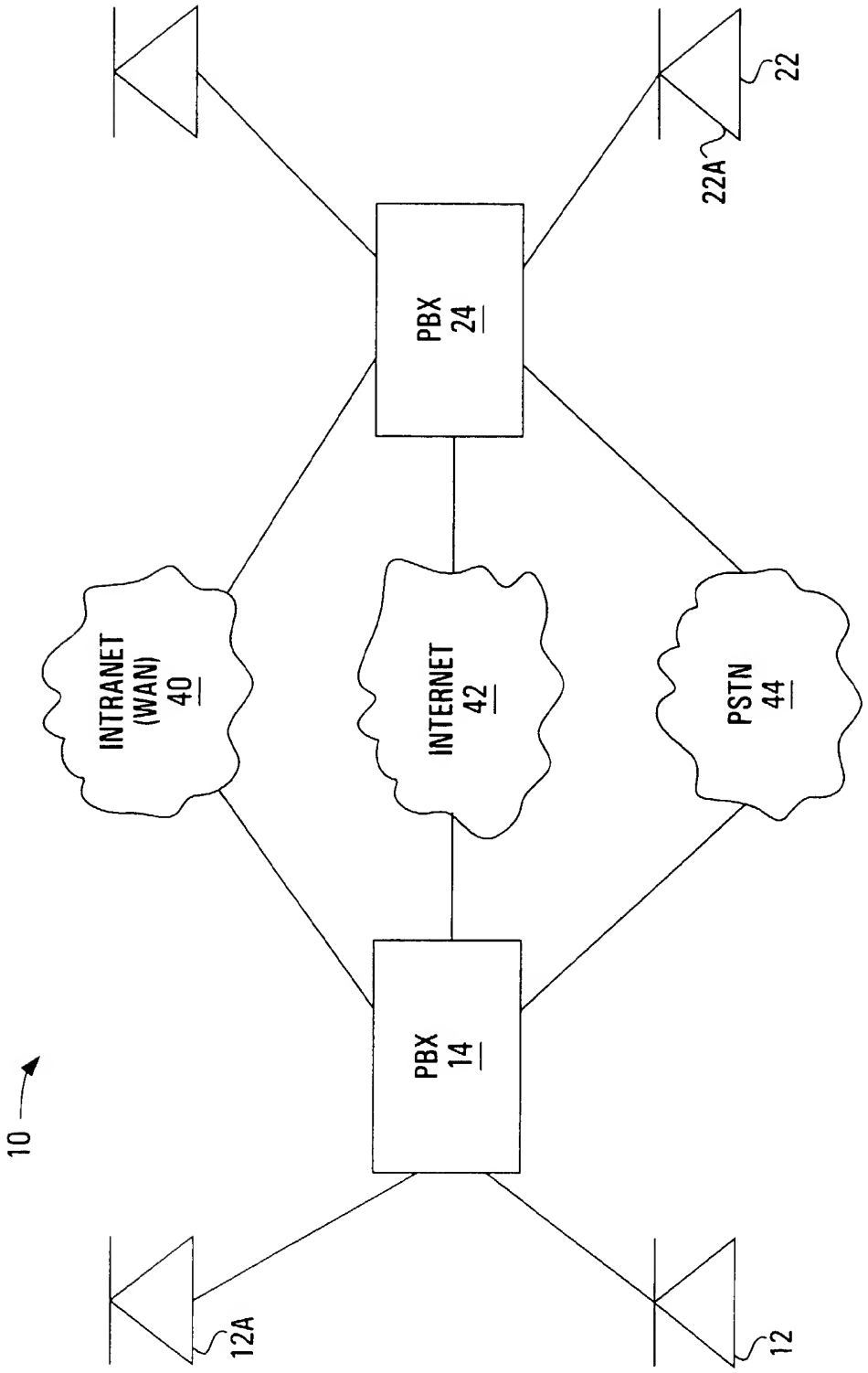
10
PBX
14
PBX
24
INTRANET
(WAN)
40
INTERNET
42
PSTN
44
12
12A
22
22A

FIG. 1

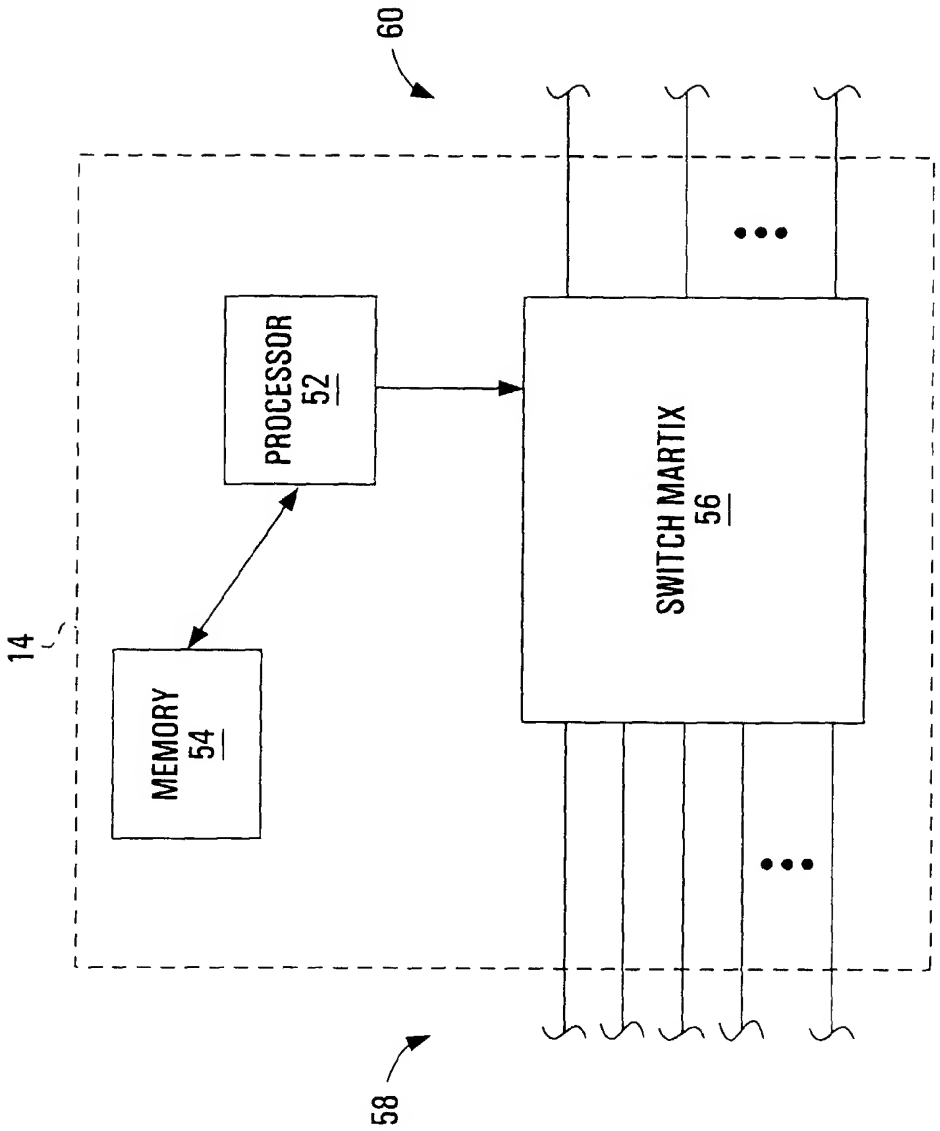

FIG. 2

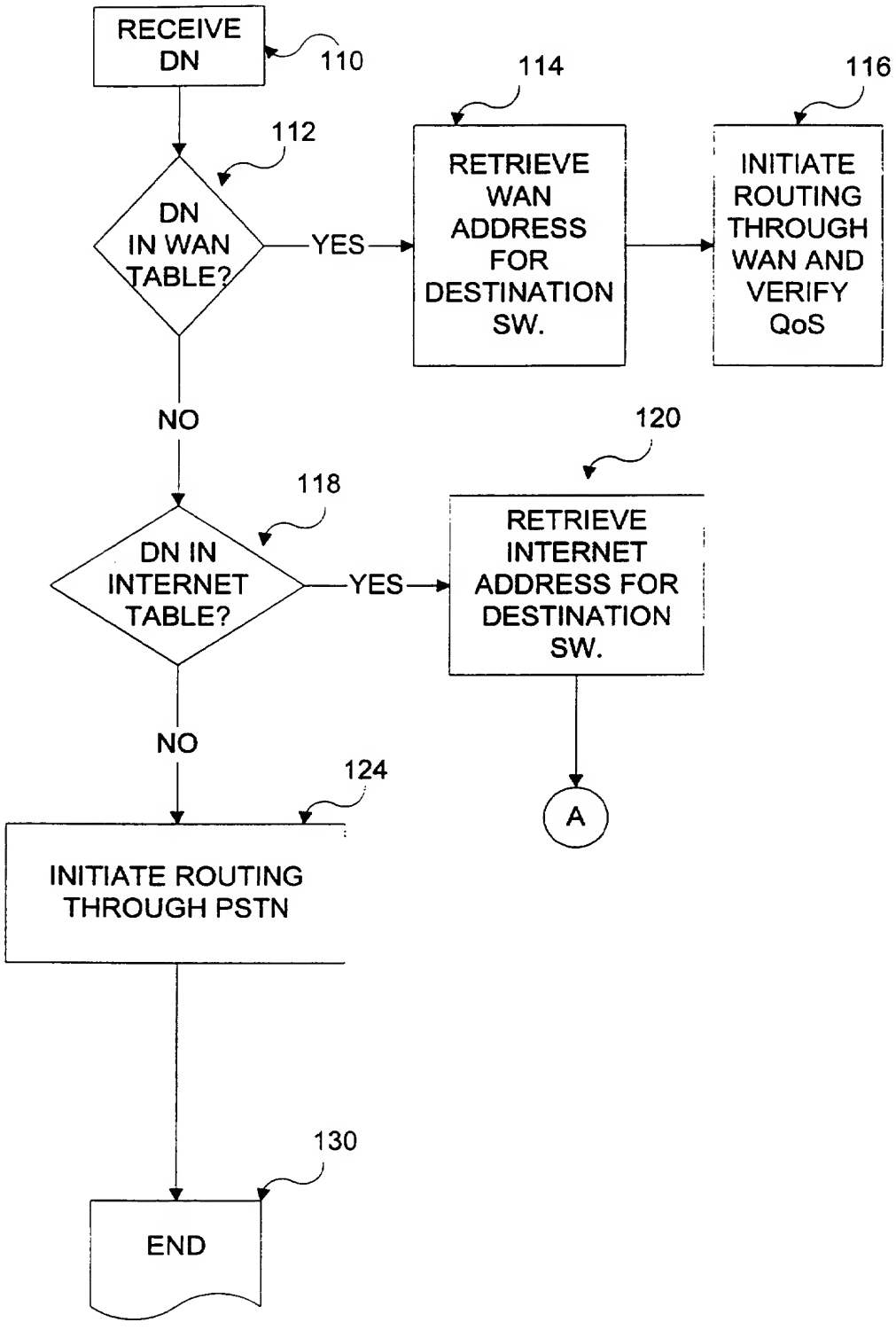
RECEIVE DN
110
112
DN IN WAN TABLE?
YES
114
RETRIEVE WAN ADDRESS FOR DESTINATION SW.
116
INITIATE ROUTING THROUGH WAN AND VERIFY QoS
NO
118
DN IN INTERNET TABLE?
YES
120
RETRIEVE INTERNET ADDRESS FOR DESTINATION SW.
A
NO
124
INITIATE ROUTING THROUGH PSTN
130
END

FIGURE 3a

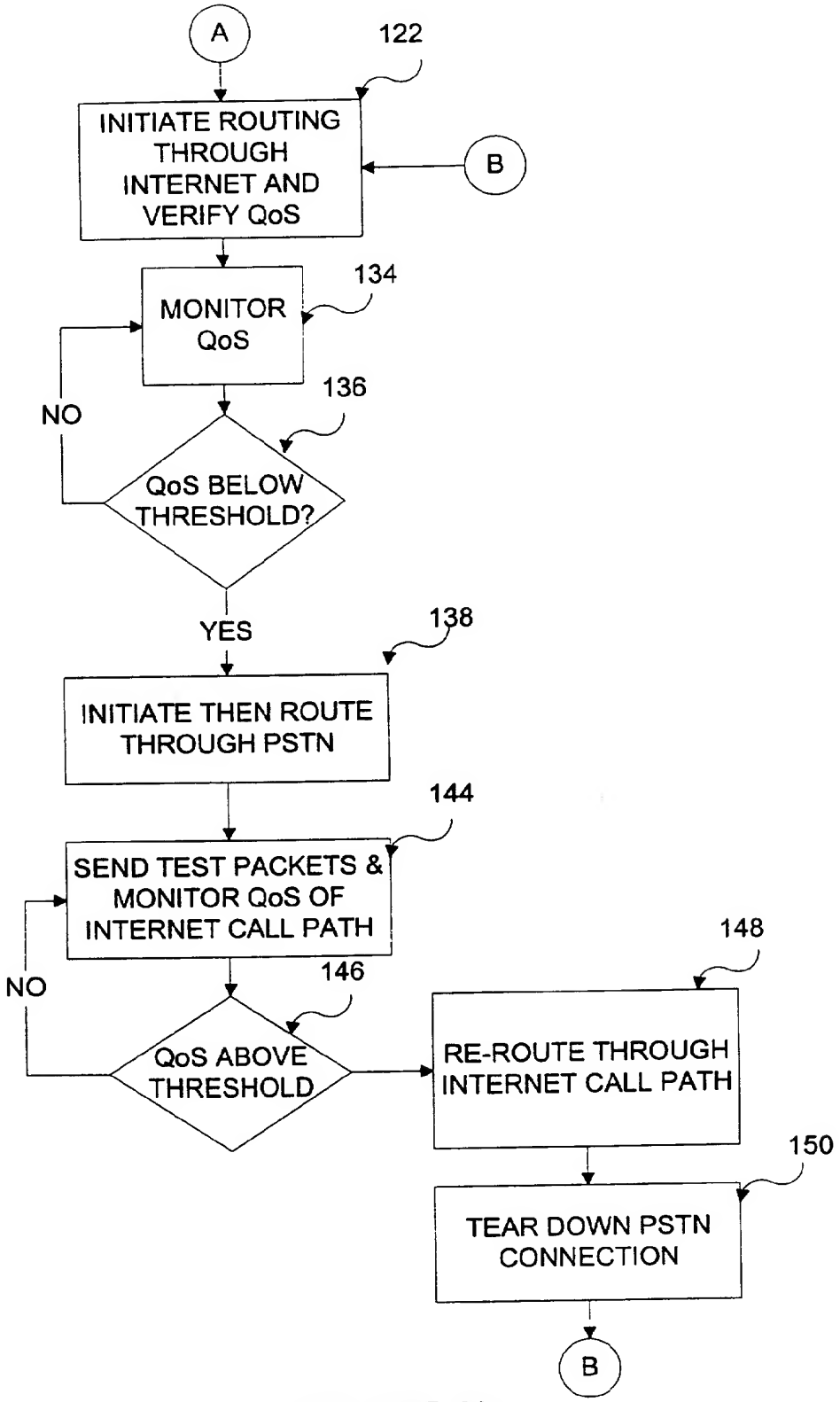
A
122
INITIATE ROUTING THROUGH INTERNET AND VERIFY QoS
B
MONITOR QoS
134
NO
136
QoS BELOW THRESHOLD?
YES
138
INITIATE THEN ROUTE THROUGH PSTN
144
SEND TEST PACKETS & MONITOR QoS OF INTERNET CALL PATH
148
NO
146
QoS ABOVE THRESHOLD
RE-ROUTE THROUGH INTERNET CALL PATH
150
TEAR DOWN PSTN CONNECTION
B

FIGURE 3b